Resonance

Physics | Acoustics | Wave Motion

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f513bf2739d0a0003ee3f5a

Teacher information

Application

Body of instruments as resonating body

Resonance occurs when vibrating systems are excited at their natural frequency. This can occur with mechanical oscillators as well as in acoustics and other areas. In this experiment, the students devote themselves to acoustic resonance and link it to the knowledge already acquired about standing waves.

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Other teacher information (1/2)

Prior knowledge

Before performing the experiment, students should already have studied standing waves and know what the natural frequencies of a body are.

Scientific principle

In this experiment the students determine resonant frequencies of an open glass tube and a frame drum. They also record a resonance curve for the frame drum. They use the software measure Acoustics.

Other teacher information (2/2)

Learning objective

When hollow bodies and other vibrating systems are excited at one of their natural frequencies, they amplify the vibration. This behavior is called resonance. In acoustics, it is expressed by the fact that in the case of resonance, the amplitude of the measured sound increases significantly.

Tasks

The students examine a glass tube and a rament drum for resonance by exposing them to different frequencies using the measure Acoustics software. They connect the resonance frequencies of the glass tube with its natural frequencies and determine the natural frequencies of the rim drum by means of an amplitude-frequency diagram.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

Further notes

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The loudspeaker and microphone have properties that may influence the result. On the one hand, both have a specific frequency response, which means that the loudspeaker cannot reproduce sounds of all frequencies or reproduce them at the same volume. The microphone also does not record all frequencies with the same sensitivity. In addition, loudspeakers have resonance frequencies, some of which are very noticeable. You can find out in which range these frequencies lie by placing the microphone in front of the loudspeaker, changing the frequency of the sound at constant amplitude between 200 Hz and 2000 Hz and observing the relative amplitude of the microphone recording while doing so.

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Student Information

Motivation

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Musical instruments as resonating bodies for amplifying sounds

There are resonance boxes for tuning forks, which can considerably amplify the volume of their sound. The resonance box is a hollow body with certain dimensions and is usually made of wood or metal. Resonance boxes or bodies are a component of many musical instruments. The dimensions and shape of the resonance box also play a major role in the construction of loudspeakers. One speaks of resonance when a vibrating body is excited with its natural frequency. This causes it to amplify vibrations.

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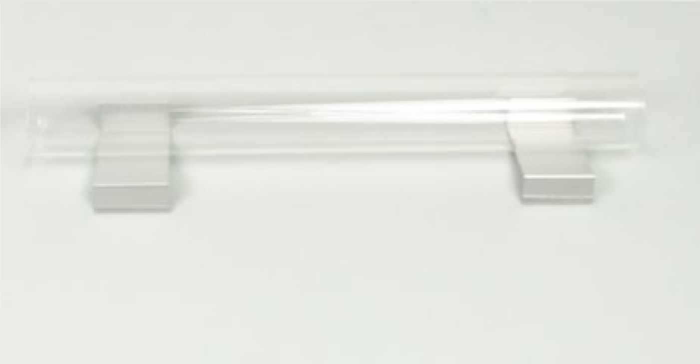
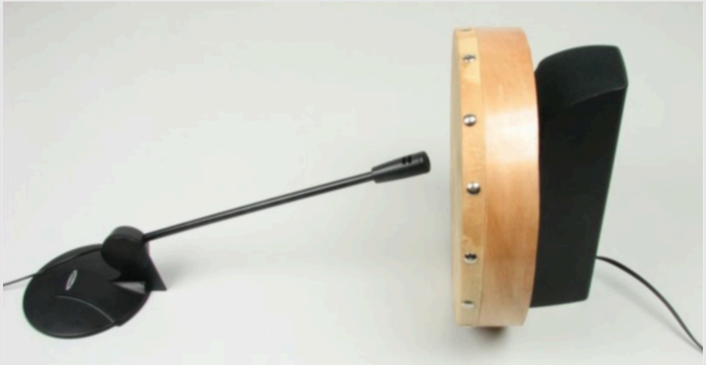
Tasks

Investigate in this experiment at which frequencies a glass tube and a frame drum reach a state of resonance.





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Equipment

Position	Material	Item No.	Quantity
1	Software "Measure Acoustics", single user license	14441-61	1
2	Metal angle bracket for glass tube o.d. = 44 mm	13289-16	2
3	Glass tube, d(outside) = 44 mm, l = 340 mm	13289-20	1
4	Frame drum, d = 20 cm	13289-11	1

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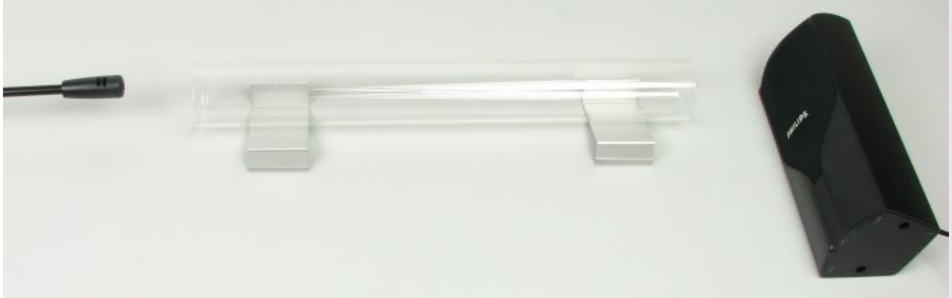
Additional equipment

Position	Equipment	Quantity
1	Microphone	1
2	Speaker	1
3	PC	1

Setup - Part 1

- Connect the speakers and microphone correctly to the computer.
- Place the glass tube on the two metal brackets.
- Open the audio settings of the PC. Adjust the output volume to the maximum and adjust the balance so that the output is only from one of the two speakers.
- Place the microphone at a distance of 5 cm in front of one opening of the glass tube.
- Place the loudspeaker 5 cm away transversely in front of the other opening of the glass tube.



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Procedure (1/2)

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- Start the software measure Acoustics and open the experiment "2.7 Resonance".

Help 1: Open the experiment overview (menu item "File" → "Open experiment" or select "Open experiment" from the menu bar). Select the experiment "2.7 Resonance" from the folder "2 Physical Basics: Vibrations and Waves".

- Starts playback of the preset sound with the frequency of 100 Hz through the speaker.

Help 2: In the diagram "Spectrum of the signal at the audio output (loudspeaker or headphones)" start playback with "Start".

- Make sure that the relative amplitude of the generated sound is always 100%.

Help 3: Activate the button "Constant Amplitude".

Procedure (2/2)

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- Now change the frequency of the sound between 200 and 2000 Hz.

Help 4: Drag the "Sound" symbol slowly with the mouse over the diagram area.

- During this time, observe the relative amplitude of the microphone recording over time.
- Note for which frequencies the relative amplitude of the microphone recording takes on increased values.

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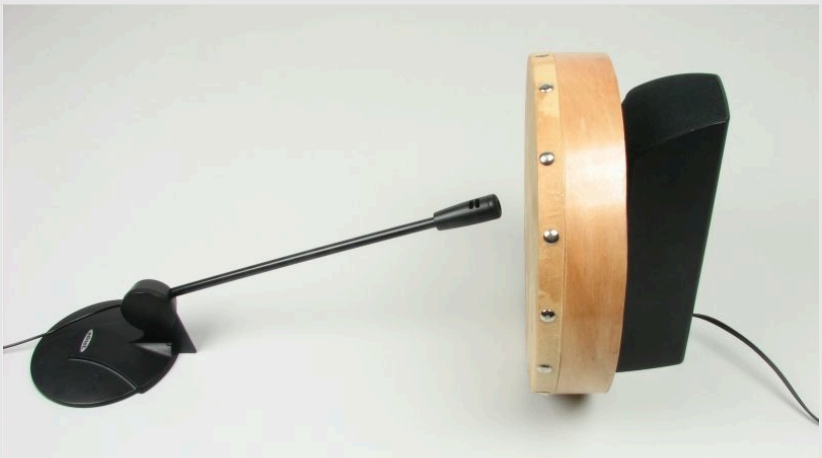
Setup - Part 2



Frame drum in front of the loudspeaker, the microphone centrally in front of the drum membrane

- Now place the speaker upright.
- Place the frame drum on its frame directly in front of the speaker. If necessary, lean it a little against the speaker. The hollow side of the frame drum should face the speaker.
- Place the microphone so that the microphone head is about 2 cm from the centre of the drum membrane.

Implementation

- Set the relative amplitude of the tone in the tone generator to 100% and the tone frequency to 200 Hz.

Help 5: Right click on "Sound" of the preset sound and select the "Tone Generator" menu.

- Play the sound at a frequency of 200 Hz (see Help 2). Adjust the volume on the speaker so that the recorded relative amplitude is approximately 2 to 3%.
- Now measure the relative amplitude of the microphone signal depending on the frequency of the sound played. Start with one tone at 100 Hz and then increase the frequency in steps of 20 Hz to 500 Hz at constant amplitude (see Help 4 and possibly 3).
- If sufficient time is available, record additional measuring points between 250 and 350 Hz.

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Report

Task 1

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Note for which frequencies the relative amplitude of the microphone recording assumes increased values (resonance frequencies of the glass tube).

	ResFreq 1	ResFreq 2	ResFreq 3	ResFreq 4	ResFreq 5
Frequency in					

Note the relative amplitude of the microphone signal for frequencies between 100 Hz and 500 Hz.

	Ampl100	Ampl200	Ampl300	Ampl400	Ampl500
relative amplitude in %					

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Task 2

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Standing waves

$f = \frac{\quad}{\quad}$

2 L k θ

Check

Calculate these natural frequencies of the glass tube for a length of 34 cm.

Eigfr 1

$k = 1$

Eigfr 2

$k = 2$

Eigfr 3

$k = 3$

Eigfr 4

$k = 4$

Eigfr 5

$k = 5$

Task 3

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Compare the natural frequencies with the resonant frequencies you found. What do you notice?

- They're the same.
- They're not the same.

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Slide	Score / Total
Slide 19: Standing waves	0/4
Slide 20: Response	0/2

Total amount 0/6

Solutions Repeat Exporting text

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